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Nourishment of the Foetus in Utero

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A
DISSERTATION
on the
Nourishment of the Foetus
in Utero:

With some observations on the effects of Utro Gestation
on the Maternal system;
And on
The commencement and effects
of Respiration

Chapter first

On the nourishment of the Foetus in Utero

Section first

Of the commencement of life

When we contemplate the numerous orders of organized being, from the short lived vernal plants to the tree of ages; from the plant which scarce peeps from earth, to the cedar of Lebanon; from the ephemera, to man; from the animalcule, to the whale; from those animals and plants which almost perish in the winter of a tropical climate, to those which flourish on the mountains of the North: When we reflect on all the variety in the duration of life; in the magnitude of its productions; in the organization that it produces; and in the circumstances in which it flourishes or languishes, we can hardly

withhold to subscribe to the idea, that life varies as the orders of being to which it belongs vary, and that determining the organozation according to the variety, it thus secures the perpetuity of the order by reproduction.

That life is produced by an appropriate operation of the rudiments of the embryo on each other, is a proposition compatible with the common sense of man.

The laws by which life is thus produced, and by which it is afterwards continued, being enacted by that Omnipotent Word which said: "Let them bing forth after their Kind," are as immutable as the laws of light, attraction, repulsion &c which were originated by the power of the same Word.

That the operation of the rudiments of the embryo on each other by which life is commenced may be appropriate a variety of circumstances must be favorable. Without entering into a detail of those circumstances

I will only remark that the catenation of actions by which the communication is made, however complex, takes place in organs endued with the appetency of being excited by the stimulating impreſsion of the rudiments of the embryo, to that precise train calculated to produce the effect. Hence the conclusion that the actions by which the communication of the rudiments of the embryo is effected and the fecundated ovum conveyed to the receptacle in which the first and most important exertions of its powers may be made, are not actions of life in the embryo itself, but in the parental organs.

Having now advanced the idea that life is produced by the appropriate operation of the rudiments of the embryo; that it is various in the various orders of organized being; that according to its variety it determines the organization, and thus secures the

perpetuity of the order by reproduction, and that the actions by which life is both produced and afterwards continued are governed by immutable laws, I proceed to consider the first actions of life in the human embryo.

Section second

Of the establishment of a connection and intercourse between the human embyo & mother

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Life first manifests itself in the powers of organization, and of acquiring those principles neceſsary for the support of its own actions. The first actions of life are exerted in the production of an organ through the medium of which, those neceſsary principles may be acquired. The organ produced for this purpose in the human embyo is the umbilical vein.

The principles to be acquired I will

term the nutritive principles without having regard at present to the source whence they are originally derived.

Without a supply of the nutritive principles vitality cannot continue its actions.

The first actions of life are supported by the nutritive principles secreted in the ovum. In oviparous animals and in the seeds of plants, that secretion is considerable.

I must now assume it as a proposition, that between the vital and nutritive principles, there is a peculiar affinity existing, whereby, through the medium of ~~the medium of~~ the organ produced for the purpose, which in the human embryo is the umbilical vein, a supply may be obtained as follows. The production of the umbilical vein is necessarily attended with some exhaustion of those principles which supported the actions by which it was produced. By

this state of exhaustion the affinity of the vital for the nutritive principles is aroused to more energetic exertion. The arteries of the mother are copiously supplied with the principles required, Whereby the umbilical vein is attracted to the vascular parietes of the uterus or to some other vascular surface (for although the ovum escape into the cavity of the abdomen it may yet live)

The place where the veſsels of the mother and embryo come in contact becomes the centre of a beautiful train of action. While the veſsels of the mother, copiously supplied with the nutritive principles, readily yield a portion to the veſsel of the embryo, which, under the influence of that affinity by which it was received, is conveyed, through the medium of that veſsel to the embryo itself, as if to establish an equilibrium, the neighbouring veſsels of the mother influenced by the

same principle contribute to replenish those veſsels partially exhausted by the supply they have yielded; and thus the whole maternal system may be brought to contribute.

This connexion and intercourse being established the supply must be equal to the demand.

The restoration of the circulation in a limb in which it has been partially interrupted by the tying of a principle artery, affords a remarkable instance of how great an effect the affinity between the nutritive and vital principles is capable of producing.

Under the influence of attraction there is in nature a great tendency to an equilibrium. Whatever powers may be exerted to destroy it, whether repulsion, counter attraction, condensation or mechanical

force, yet the tendency to an equilibrium is in all cases manifest. Perhaps there are few now of common information who cannot give a plausible theory of the winds and tides. The phenomena of caloric, electicity and all the variety of chemical affinity are manifested in a tendency to an equilibrium

Carbonate of potash absorbs moisture from the atmosphere. A bean, an acorn, or a persimmon seed will absorb moisture from the earth. In either of those cases the absorption equally takes place in consequence of an affinity. If the potash were placed under such circumstances that all the moisture absorbed would be retained it would soon arrive at a state of equilibrium with the atmosphere and would cease to absorb; but if it were by a superiour affinity deprived

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of its moisture as fast as absorbed, then the equilibrium could not be formed and ~~the~~ the absorption would go on; so, if by the proceſs of vegetation the equilibrium were not constantly destroyed the bean &c would cease to absorb.

That in the human body the actions of life may destroy the equilibrium and thus excite or increase the affinity for those principles calculated to restore it, is not contrary to reason, and, I think, will by observation be found true. This is the principle hypothesis on which I proceed; but in this limited diſsertation I shall not, by any means, be able to shew its importance

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Section third
Of the distribution of the nutritive supply in the embyo.

Under that attractive influence that we have described as excited by want and as exerted to establish an equilibrium, the supply from the mother must tend to that point where the need is greatest. The need must be greatest at the point where the vital action, having commenced, has produced the first exhaustion. The tendency of the nutritive supply being originally towards the *principle* seat of the sensorium, induces us to believe that there vital action commences.

When the *principle* seat of the sensorium is supplied, and thereby rendered capable of a farther exertion

of its powers, the demand in the lower portion of the embryo preponderates. The medulla spinalis, by attracting the nutritive supply required, causes it to form the arch of the aorta, and to descend with itself.

I will here observe, that, I suppose the sensorium endowed with the powers of life manifested in organization, nutrition and growth. Those actions cannot be carried on without a constant consumption of the nutritive principles. This consumption destroys the equilibrium and excites the affinity for a fresh supply.

When affinity exists between two bodies the attraction exerts an equal force on each; but if one be a fluid, it will yield to a force whose impression would hardly be perceived on a solid. The blood is a fluid which has an affinity for the nutritive principles.

but an affinity inferior to what the sensorium has. The blood may be compared to a pendulum suspended between a positive & negative electric.

Our theory of the distribution of the nutritive supply is, that as organization progreſses, or wherever vital action is carried on, the blood in consequence of the nutritive principles it contains is attracted by the sensorium. By pursuing this theory we might trace the circulation through its most minute ramifications, and show how every muscular fiber &c. nourished and actuated by its appropriate nerve requires and elicits its appropriate artery. We will however be content with the general position, that on this principle it is distributed to every part as there is demand, and that, as the demand

increases the supply must also increase.

Although the commencement of the circulation may be effected by the affinity of the vital for the nutritive it could in that way be carried on but slowly; the heart therefore must be considered as an auxiliary in carrying on the circulation, but it becomes so powerful an auxiliary, that the primary power is hardly recognized.

Section fourth

Of the proceſs of nutrition

Our method of accounting for the proceſs of nutrition may be at once apprehended from what precedes; but we would hardly feel justifiable in omitting to appropriate as

section more particularly to that subject. Vital action, as I have before mentioned, is supported by the nutritive principles. That action by which the nutritive principles are abstracted from the arterial blood is called secretion. Secretion is naturally divided into two classes:

1st the secretion of fluids for the support of the system in its various actions and parts, and

2nd the secretion of fluids excrementitious.

The second class of secretion is very inconsiderable in the foetal state; for in consequence of the purity of the supply afforded the foetus, very little excrementitious matter remains, perhaps not more in general than may be retained as the meconium urine &c

Blood has an affinity for the nutritive principles, but an affinity weaker

than the sensorium has, and when deprived of those principles by the stronger affinity of the sensorium it ceases to be attracted for the attraction existed only in consequence of the nutritive principles in combination with it.

The proceſs of nutrition, considered after the nutritive principles are received into the circulation, is, according to what is above advanced, performed by the sensorium, and consists in its abstracting those principles from the blood ~~and~~ and appropriating them to the purposes of the animal oeconomy.

It is a question of future inquiry, whether the blood at the time it yields its nutriment, does not also receive from the sensorium principles which characterize its venous state?

When reflecting on the neceſsary tenuity

of a fluid secreted through the coats of the capillary veſsels and on the rapid but uniform condensation of it caused by the vital action we cease to view as a subject inexplicably mysterious, the evolution of animal heat of a uniform temperature.

Section fifth
Of the return of the venous blood

By the influence of the sensorium the blood is rendered venous and in that state is subject + to an attractive influence very different from that of the arterial blood; for in consequence of its affinity for the nutritive principles uninterrupted by any counter attraction, (except in some situations gravitation) it is attracted towards the greatest and most contiguous supply which is in

general the column of arterial blood nearest the heart.

'Tis easy to imagine how the venous blood under this attractive influence may retrace the arterial; but it must be remembered that the arterial blood will only yield the nutritive principles to the superiour demands of the sensorium.

I have compared the blood to a pendulum suspended between a body positively and one negatively electrified. A pendulum suspended between an insulated conductor in which there is an accumulation of electricity, and a conductor not insulated in which there is no such accumulation, will, if within the sphere of their influence and negative, be attracted to the positive; the positive conductor yielding to it a quantity of electricity sufficient to establish between them an equilibrium. An equilibrium being established the attraction ceases; but the equilibrium

between the pendulum and negative conductor being destroyed, the pendulum is attracted to it and to restore the equilibrium imparts its excess of electricity: upon which the attraction ceasing as above; and the pendulum being rendered negative, it is again attracted by the positive, and so on alternately as long as an inequality is kept up. Such is the attraction of the arterial blood by the sensorium and of the venous blood by those principles calculated to render it arterial

Upon the principle on which ~~that~~ I have above accounted for the return of the venous blood, it must in ascending form an arch with the aorta if not diverted by some superior attraction consequent upon an alteration in ~~his~~ its qualities. But on meeting with the highly charged arterial blood of the umbilical vein, the attraction being so great as to cause anastomosis, it blends with it, and thus

rendered arterial, is no longer influenced by the arterial blood in the Aorta, but follows the established course of the supply from the mother. If the attraction were not sufficient to cause anastomosis, the venous blood would, upon our principle, retrace the umbilical vein to the placenta.

If a portion of the arterial blood of the foetus (which is less arterial than that in the umbilical vein) arrive in the course of the circulation, (as is the case in the hypogastric arteries) at a point where the more highly charged arterial blood passing from the placenta attracts it with a force superior to that of the sensorium, but not sufficient to cause anastomosis, it must traverse it to its source upon the principle of the return of the venous blood.

Section sixth
Of the placenta

If an affinity exist between two bodies the power of attraction exerted by each is equal. Having this circumstance in view it requires no great stretch of imagination to conceive that while the veſsels of the foetus are attracted by the nutritive principles in the maternal veſsels, the maternal veſsels attracted by an equal power, are influenced to grow out and interlock with the foetal veſsels. In this manner I would account for the production of the placenta. Its size bears a proportion to the number of veſsels thus interlocked, though it may in some degree be influenced by a more or leſs copious interstitial deposition; and the number of veſsels, both foetal and maternal, is proportioned to the supply required.

The advantages arising from the well known structure of the placenta appear very considerable when we consider how great facility this structure affords to the transfer from the maternal to the foetal veſsels.

I conceive it poſsible that an action analogous to double elective affinity may take place in the placenta, and that while the nutritive principles paſs from the maternal to the foetal, Carbon may paſs from the foetal to the maternal veſsels. If such an action do take place in the placenta the carbon must be in combination with a very subtile fluid: perhaps it may be in the state of carbonous oxide. An enquiry on this subject will become more neceſsary when I come to speak of the commencement and effects of respiration

I do not believe that a veſsel can be

produced by any other power in the animal oeconomy but the power of organization. The power of organization in such a case as the production of the maternal vessels of the placenta requires some exciting ~~power~~ cause of action. The exciting cause of action I would state to be the attraction as above and the consequent greater determination of arterial blood to that part.

I have now in a diffuse manner said as much as I intended on the nourishment of the foetus in utero.

The limits I have fixed to my dissertation have prevented my introducing that evidence that analogy furnishes in support of the ~~wd~~ sentiments I have advanced. In the different orders of organized being, the power of taking into the circulation and disposing of those principles which

are peculiarly adapted to support the vital action in each, forms a general analogy between orders of the most complicated ~~structure~~ and most simple structure.

The whole proceſs of vegetation evidences an attractive influence. By what other power is the circulation in plants effected? Why, but in consequence of ~~affin~~ attraction arising from a peculiar affinity, do the roots of plants run near the surface in seasonable weather and descend in drouth? the tops removed from the light incline to it as if by a voluntary exertion? the pistil & stamen incline to each other as in Collinsonia; and the leaves absorb and give out air? That motion not caused by a propulsive must be caused by an attractive influence; unleſs, (as is sometimes the case) both an attractive & propulsive influence concur to produce the same motion.

Chapter second
Of the effects of Utero gestation on the maternal system

Section first
Preliminary observations

The particular design of this chapter is to maintain that many of the effects, caused, by Utero gestation, on the maternal system, may be rationally referred either directly or indirectly to that abstraction of the nutritive principles which go to the nourishment of the foetus, but which otherwise would have supported the accustomed vital action of the mother.

It is neceſsary that I should use much brevity, therefore the importance of my position and the extent of its application will but imperfectly appear.

Section second

Of the growth of the Uterus

The growth of the gravid uterus is the first effect of Utero gestation that I will attempt to explain.

The abstraction from the maternal system is made through the medium of the Uterus.

The determination to the uterus, by causing an unusual quantity of arterial blood to circulate through the Uterine vessels, and to be brought within the sphere of the influence of the uterine nerves, causes in that organ an increased secretion, which, under the influence of the power of organization now aroused to more energetic action, is appropriated to its nourishment and growth

Section third

Of Constipation, dispepsia and their train

If the demands of the foetus can cause the whole maternal system to contribute to their supply, as stated in the second section of the preceding Chapter, then, every part of the mother may be sensibly affected by the privation thus produced; for, if vital action is supported by the nutritive principles, parts deprived of their usual supply cannot act with their usual vigour.

The determination to the Uterus may diminish the usual determination to the alimentary canal, and thus diminish the usual energy of its action, whereby will be caused dispepsia constipation and their numerous train of consequences, as an accumulation of crudities on the stomach

cardialgia, nausia, vomiting, pain in the head, fever and emaciation.

Dispepsia and constipation are the direct ~~consequences~~ consequences of the diminished action of the alimentary canal. These are always in a greater or leſs degree according to the particular circumstances of the case. Directly resulting from them are, an accumulation of crudities on the Stomach, Cardialgia, nausia, and Vomiting. Now, these last, may irritate the Stomach so much as to increase the determination to that organ and thus excite its healthy action. But if ~~they~~ have not this effect, then there is neceſsarily a suspension in the usual mode of supplying the system with the principle of nourishment derived from aliments, as the chyle cannot in this case be elaborated. If the dispepsia were complete death must speedily ensue, unleſs there were some other

source whence the demand of the system might be supplied; for as vital action is supported by the nutritive principles, if those principles can be no longer acquired vital action must cease. The adipose deposition in the cellular texture is the principle source whence a supply may be obtained by which vital action may in so extreme a case receive temporary support. According to the activity of vital action will be the rapidity with which this source of supply is exhausted. This supply is taken into the circulation by absorption, which, it has now become necessary for me briefly to explain.

In entering upon this explanation I must lay down the proposition, that, between the nutritive principle derived from atmospheric air and that derived from aliment there exists a strong and peculiar affinity analogous to that which influences the return

of the venous blood. In support of the existence of such an affinity much argument might be used. Under its influence the chyle may be so attracted as readily to enter the mouths of the absorbents, and to retrace the arteries; but if the chyle be not elaborated, or not in quantity sufficient to supply the demands of the system, its deficiency in the blood will increase the attraction, and a determination will take place towards the supply deposited in the adipose membrane. In consequence of this determination there will be an unusual evolution of animal heat towards the surface; the fat will be diſsolved and perhaps receive or give up some principle which alters its mode of existence, and will be made to enter the absorbents and retrace the arteries as chyle or venous blood does. Add to this, that blood not duly supplied with the nutritive principle

derived from aliments is an irritant to the sensorium and we have the cause of the head-ache, fever, and emaciation.

Section fourth

Of affections of the lower extremities

The determination to the uterus may in a remarkable degree diminish the determination to the lower extremities, and thus cause in them a sense of inaction and deadneſs to a distreſsing extent; and the descending column of arterial blood being insufficient to facilitate the return of the venous blood, or to carry on an active absorption, there ensues the formation of varicose veins, and oedematous swellings.

The muscles, in consequence of the privation they sustain may be affected with soreneſs, Cramps, and perhaps with convulsions.

Section fifth

Some general observations

There is something analogous to a constant contention and struggle between the maternal & foetal systems, and if at any time, from violent action in the voluntary muscles or from strong counter irritation the determination is diverted from the Uterus, the foetus must suffer may perish

I will conclude this chapter by adverting to what I consider a chief cause of pain in the first stage of parturition - The contraction of the uterus diminishes the diameters of its vessels by which the circulation is diverted from it, first to the lower extremities. The increased quantity of fluid thus made suddenly to pass in the arteries going to the lower extremities I believe to cause much pain, partly by distension and partly by the unusual quantity of arterial blod supplied to the sensorium about the loins & hips especially -

Chapter third
Of the commencement and effects of respiration

Section first
Of the commencement of respiration

By the contraction of the Uterus in parturition the nutritive supply from the mother to the foetus is gradually diminished, whereby the whole foetal system, but particularly the organs of respiration are affected in the same manner that they are subsequently liable to be by suffocation.

This at length amounts to convulsions.

A convulsive contraction of the respiratory muscles enlarges the cavity of the Thorax, which, upon a well known principle, causes the first inspiration.

When the convulsive contraction has subsided expiration might be caused by the elasticity

of the parts returning them to their usual situations; but it is aided by a convulsive action of the abdominal muscles, whereby is produced violent expiration attended with sneezing, coughing, crying &c.

If there be an obstruction to prevent the airs flowing into the lungs when the muscles act, then, but little perceptible effect can be produced; for the strength of the muscles is not sufficient to overcome atmospheric preſsure, and make in the thorax a vacuum. A tremulous motion might probably be observed.

Having, now, briefly explained the commencement of respiration, I proceed to the consideration of its effects; and I will commence with

Section Second

The change in the circulation at birth

Anteriour to birth the nutritive principles

were derived from the mother in a state of intimate combination. It was therefore unneceſsary, when treating of the foetal nourishment to point out the sources whence those principles were originally derived. It has now become neceſsary in treating this part of my subject that I should explicitly mention, that, that principle which peculiarly characterizes arterial blood is derived from atmospherick air.

I have explained, how, under the influence of the attraction of arterial blood, the venous blood might be made to retrace the arteries. I have also explained, how under the influence of an analogous attraction the nutritive principles derived from aliments might be taken into the system, and other cases of absorption carried on.

If we can conceive that arterial blood is capable of exercising such an influence we can also readily conceive, that, that

principle which renders it arterial is capable of exercising an analogous influence. I therefore proceed upon the idea that atmospheric air is capable of attracting venous blood.

As an evidence of the existence of such an attraction I would introduce the circumstance of the determination to the surface in cases of suffocation, or even in voluntary suspension of respiration.

As soon as respiration commences, the venous blood, attracted by the air diffused through the air cells of the lungs, sustains to those organs a copious determination which taking off the pressure through the foramen ovale and ductus arteriosus allows them to close gradually.

When the blood has undergone that change and received that principle

by which it is rendered arterial it retraces the venous blood to the heart How the arterial and venous blood may here influence each other may be understood from what I have before advanced

It must not be denied that the blood in the left auricle and in the aorta in some degree counterbalances the blood in the right auricle and in the pulmonary artery and opposes some resistance to its flowing freely through the foramen ovale and ductus arteriosus; But when we reflect upon all the mechanical aid that can in this case be afforded we find it incompetent to account for the effect produced; I therefore conclude by observing that the blood is determined to the lungs by its attraction for a certain principle in the air dif-

-fused through the air cells.

Section third

Of the decarbonization of the blood

In speaking of the placenta I admitted the possibility of an action in that organ analogous to double elective affinity; I come now to speak of an action in the pulmonary organs that I suppose similar.

The production of carbonic acid gas in respiration is an important physiological fact. What gives the carbon in this case so great an affinity for oxygen that, at the temperature of animal heat, the coats of the vessels interposing will not prevent its combining with it is the first question that excites my curiosity; my curiosity is the more excited when I reflect that the carbon is taken from a fluid incombustible

I suggested that the carbon perhaps existed in the state of carbonous oxide. The reflections which led to that idea I will briefly state as I cannot at present experiment on the subject as was my desire.

Carbon remains fixed in the most intense heat if oxygen be excluded; therefore caloric alone cannot hold it in solution.

Pure carbon, the diamond, is combustible at 14° Wedgewood or 2897° Fahr.

Charcoal an oxide of carbon burns at 1° or 2° Wedgewood or at 1000° or 1500° Fahr.

If caloric alone will not hold carbon in solution; If its being suspended in an incombustible fluid of the consistence of blood or ~~of~~ even of water will not facilitate its combustion; if the purest carbon require for its combustion the highest temperature; and if combination

with a portion of oxygen render more easy the combination with an additional portion; then I infer that the combustion of pure carbon does not take place in the lungs, but that the carbon is combined with the greatest portion of oxygen below saturation.
This must remain a subject for future investigation.

To suppose, in the foetus, the carbonous oxyde to be elaborated by the action of the sensorium on the nutritive supply, and to be taken up by the blood at the time it parts with its nutritive principles to the sensorium; to suppose a similar exchange again to take place in the placenta between the maternal and foetal veſsels; and again, an exchange not much diſsimilar, to take place in the lungs of the mother in which the carbonous oxide (perhaps positively electrified) unites with an additional portion of oxygen and is expired, would not seem wholly irrational

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